

# A Process for Producing High Speed Transmitting Dielectric Material

## BACKGROUND OF THE INVENTION

### 5 1. Field of the invention

The invention relates to a process for producing high speed transmitting dielectric material, and in particular, to a process for producing high speed transmitting dielectric material by reacting directly polyphenylene ether (PPE) with an epoxy, characterized in that said PPE needs not to  
10 be cleaved into small molecules, and can therefore shorten greatly the reaction time. The process of the invention is applicable in the manufacture of printed circuit board material used in wireless communication, base station and the like.

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### 2. Description of the prior art

Conventional processes for producing high speed transmitting dielectric material comprised of, as shown in Fig. 7 and 8, cleaving firstly a  
20 polyphenylene ether (PPE) (A) of high molecular weight into PPE (B) of small molecular weight through chain cleavage with a peroxides, and then, after mixing with an epoxy resin (C) (a solvent-type epoxy of low bromine content), carrying out a reaction in the presence of a catalyst and a hardener to produce dielectric materials such as a prepreg,  
25 copper-clad laminate (CCL) and the like.

However, the above-described conventional processes had the following disadvantages:

1. Since current high frequency substrates or wireless communication substrates must have a certain specification, for example, when the specification of a product regulates the substrate at a thickness of below 1.6 mm, a dielectric constant of less than 4.0 and a loss factor of below 0.01, the original characteristics of high frequency substrates or wireless communication substrates can be retained subsequently. Under this circumstance, the high speed transmitting dielectric material produced by conventional processes based on the cleavage of PPE of high molecular weight may not meet requirements of current application.
2. PPE of this specification is used only in some particular manufacturers, and has high cost. In case to be mixed with other materials, PPE of high molecular weight has to be mixed with an epoxy resin only after being cleaved into PPE of small molecular weight. Moreover, since a number of factors such as, for example, the amount of the catalyst used, the reaction temperature, the desired small molecular weight and the like must be considered in the cleavage process, these processes were considerably time-consuming.
3. In conventional process, PPE of high molecular weight must be subjected to chain cleavage, reaction and formulating in the presence of a peroxide as the catalyst under high temperature,

these all increase risks of those process.

In view of the forgoing, for improving the above-mentioned disadvantages such that PPE of high molecular weight can be mixed  
5 directly with an epoxy without necessity to subjected to chain cleavage and as a result, time required for chain cleavage can be eliminated as well as risks and problems occurred during the chain cleavage, the inventor had studied and carried out experiments extensively for many years based on his experience, and finally,  
10 developed the present invention.

#### SUMMARY OF THE INVENTION

The principal object of the invention is to provide a process for  
15 producing high speed transmitting dielectric material, characterized in that, unlike conventional processes, PPE can be mixed directly with an epoxy without necessity of cleaving PPE into small molecules, and such that the reaction time can be greatly reduced.

20 In a preferred embodiment, the process for producing high speed transmitting dielectric material comprises steps of:

a: mixing a proportion of 5%-95% of PPE with a corresponding proportion of 95% - 5% of an epoxy resin of the type of low  
25 bromine content;

b: reacting the mixture from step a in a non-polar solvent in the presence of 0.2%-1% of a catalyst in a reactor of a temperature of

90° C – 220° C;

c: as the temperature in the reactor lowered to 70° C, adding a hardener in the reactor and allowing it to be dissolved therein; and

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d: formulating PPE and said epoxy resin into a varnish before phase separating occurring;

and thereby, dielectric materials such as prepreg or copper clad laminate can be prepared.

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The drawings disclose an illustrative embodiment of the invention which serve to exemplify the various advantages and objects hereof, and are as follows:

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#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is the flow chart illustrating an embodiment of the process according to the invention;

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Figure 2 is a schematic view illustrating the step of mixing PPE of high molecular weight and an epoxy resin in the process according to the invention;

25 Figure 3 shows the structure of PPE used in the embodiment of the invention;

Figure 4 shows the structure of the epoxy resin used in the

embodiment of the invention;

Figure 5 shows the structure of 2-ethyl-4-methyl imidazole used in the embodiment of the invention;

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Figure 6 shows the structure of styrene-maleic anhydride resin (SMA ) used in the embodiment of the invention;

Figure 7 is the flow chart illustrating a conventional process for producing high speed transmitting dielectric materials; and

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Figure 8 is a schematic view showing the necessity of the chain cleavage of a conventional PPE into small molecular weight fragments to mix with an epoxy resin.

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[Symbols in the Drawings]

- A: PPE of high molecular weight
- B: PPE of small molecular weight
- C: Epoxy resin
- 1: PPE of high molecular weight
- 2: Epoxy resin

#### DETAILED DESCRIPTION OF THE PREFERRED MBODIMENT

In order to more deeply understand, the invention will be described in more detail by way of a non-limiting example as follows.

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Referring to Fig. 1, in one embodiment of the process for producing

high speed transmitting dielectric material comprises:

5        step a: mixing a proportion of 20% of PPE with a corresponding  
          proportion of 80% of an epoxy resin of the type of low bromine  
          content;

          step b: reacting the mixture from step a in toluene as a non-polar  
          solvent in the presence of 2-ethyl-4-methyl imidazole as a catalyst  
          in a reactor of a temperature of  $90^{\circ}\text{C} - 220^{\circ}\text{C}$ ;

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          step c: as the temperature in the reactor lowered to  $70^{\circ}\text{C}$ , adding a  
          hardener in the reactor and allowing it to be dissolved therein; and

          step d: formulating PPE and said epoxy resin into a varnish before  
15        phase separating occurring;

          wherein, in order to avoid vaporization of the non-polar solvent, a  
          cooling device by way of circulation can be provided further in the  
          reactor in the previous stated step b.

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          Thereafter, dielectric materials such as prepreg or copper clad laminate  
          can be prepared through the application of the above-described steps  
          where PPE of high molecular weight (1) needs not be chain cleaved  
          initially into small molecules. In another embodiment, either PPE of  
25        high molecular weight (2) or PPE of small molecular weight can mix  
          and react with an epoxy resin (2), as shown in Fig. 2, and therefore, the  
          reaction time can be reduced greatly.

Based on experiments, components of formulations used in the invention may comprise:

1. Polyphenylene ether (PPE): in a proportion of 5% - 95%, and preferably, based on the comparison through experiments of the invention, of 20%; the structure of PPE is shown in Fig. 3.
2. An epoxy resin of the type of low bromine content: in a proportion of 95%-5%, and preferably of 80%; its structure is shown in Fig.4.
3. A catalyst: 2-ethyl-4-methyl imidazole, in a proportion of 0.2% - 1%, and preferably in a proportion of 0.5%; its structure is shown in Fig. 5.
4. Non-polar solvent: toluene is used as the solvent in the invention to adjust the viscosity.
5. The hardener: may be one selected from the group consisting of styrene-maleic-anhydride resin (SMA), aliphatic amine and aromatic amine. Of these, SMA is used as the hardener in the invention; the structure of SMA is shown in Fig. 6.

According to the forgoing, the invention has the following advantages:

1. The process according to the invention comprises of reacting various proportions of PPE and an epoxy resin in a reactor at a temperature of 90° C to 220° C in the presence of a catalyst, wherein either PPE of high molecular weight or PPE of small molecular weight can react with the epoxy resin, instead the chain cleavage of PPE into small molecules employed in the conventional technology, and therefore, the production time can be shorten

greatly.

2. 2-ethyl-4-methyl imidazole used as the catalyst in the process of the invention has a high stability, and a low operation temperature such that the risk of the synthetic reaction is consequently lowered.

5 3. Since, as describe above, instead of the chain cleavage of PPE into small molecules employed by the conventional technology, the direct reaction of PPE of either high or low molecular weights in the process of invention can not only shorten greatly the production time, but also retain the original characteristics of the high  
10 frequency substrate or wireless communication substrate.

Accordingly, the process of the invention can achieve the expected purpose of the invention, and provide a process for producing high speed transmitting dielectric materials with industrial practicability.

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Many changes and modifications in the above-described embodiment of the invention can, of course, be carried out without departing from the scope thereof. Accordingly, to promote the progress in science and the useful arts, the invention is disclosed and is intended to be limited  
20 only by the scope of the appended claims.

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